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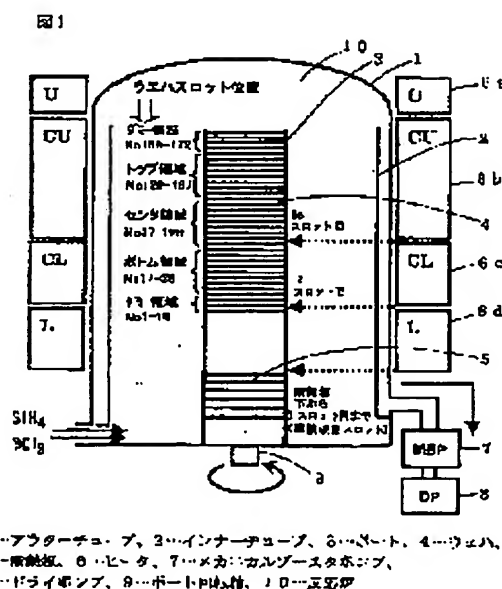
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(54) METHOD OF MANUFACTURING SEMICONDUCTOR DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a method of manufacturing semiconductor device for forming a boron-doped silicon film with an evacuated CVD method using monosilane and boron trichloride, in order to form a boron-doped silicon film which assures uniformity within the surface of film thickness.

SOLUTION: In this method of manufacturing semiconductor device, a boron-doped silicon film is deposited on the surface of a wafer 4 mounted to a boat 3 provided within a reaction furnace 10 heated with a heater 6, by operating thereto a gas including monosilane and boron trichloride under the evacuated condition. This method is characterized in that the temperature within a reaction furnace 10 is set to 460°C or higher but under 600° C.



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CLAIMS

[Claim(s)]

[Claim 1] The manufacture approach of the semiconductor device characterized by using a mono silane and boron trichloride as reactant gas, setting to the manufacture approach of the semiconductor device which forms a boron dope silicone film on a substrate with a CVD method in a reactor, and making whenever [said reactor internal temperature / at the time of said boron dope silicone film membrane formation] into 460 degrees C or more less than 600 degrees C.

[Claim 2] Where laminating support of two or more substrates is perpendicularly carried out in a reactor at a boat In the manufacture approach of the semiconductor device which introduce a mono silane and boron trichloride as reactant gas, and it is made to go up perpendicularly, and forms a boron dope silicone film on each aforementioned substrate with a heat CVD method from the furnace body lower part The manufacture approach of the semiconductor device characterized by making sum total mean velocity of the gas in said reactor at the time of said boron dope silicone film membrane formation into the rate of flow from which the homogeneity within a thickness side of said boron dope silicone film formed on each aforementioned substrate becomes 3% or less.

[Claim 3] The manufacture approach of the semiconductor device characterized by using a mono silane and boron trichloride as reactant gas, setting to the manufacture approach of the semiconductor device which forms a boron dope silicone film on a substrate with a CVD method in a reactor, and setting the partial pressure of the boron trichloride in said reactor at the time of said boron dope silicone film membrane formation to 0.7Pa or less.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] Especially this invention relates to the manufacture approach of the semiconductor device which forms a boron dope silicone film, i.e., the boron dope amorphous silicon film, or the boron dope polish recon film with a CVD method (chemical-vapor-deposition method) about the manufacture approach of a semiconductor device.

[0002]

[Description of the Prior Art]

[Patent reference 1] In the process which manufactures semiconductor devices, such as JP,5-62904,A IC and LSI, forming a thin film on a substrate with a CVD method (chemical-vapor-deposition method) is performed. Forming the silicone film which doped boron with a reduced pressure CVD method as one of such the membrane formation approaches is carried out.

[0003] Diboron hexahydride was used for doping boron to a silicone film conventionally. In this case, where laminating support of two or more wafers is perpendicularly carried out in a reactor at a boat Introduce gas from the furnace body lower part, it is made to go up perpendicularly, and the gas is used. With a heat CVD method When the low pressure CVD system (it illustrates to drawing 1) which forms a thin film on said wafer was used, in all the fields from the bottom product field in a CVD system (lower field) to a top field (up field), the homogeneity within a field of thickness and resistivity was as bad as 10 - 20%.

[0004] moreover -- from the bottom product field in a CVD system up to a top field -- the face-to-face (substrate face-to-face) homogeneity of the resistivity of (refer to drawing 1) -- temperature -- a flat (homogeneity) -- it was as bad as 30 - 40% in the condition, and although membrane formation temperature has been improved by suppressing decomposition of lowering diboron hexahydride, when membrane formation temperature was lowered, the membrane formation rate fell, and this homogeneity had the problem that a throughput fell.

[0005] It has become clear by replacing the above-mentioned homogeneity within a thickness side with diboron hexahydride, and using boron trichloride that it is improved substantially. It is compared and shown by the case where the case where used the mono silane for drawing 2 for the homogeneity within a thickness side of the boron dope polish recon film as a source of silicon, and diboron hexahydride is used for it for a boron dope, and boron trichloride are used. The homogeneity within a thickness side (however, since it expresses with the percentage of the amount of ununiformities within a thickness side, homogeneity is so good that the numeric value of an axis of ordinate is small), and the axis of abscissa of an axis of ordinate are wafer loading slot locations (refer to drawing 1) among drawing. It turns out that the homogeneity within a thickness side has improved [the way at the time of using boron trichloride rather than the case where diboron hexahydride is used] substantially so that clearly from drawing 2 .

[0006] Moreover, when the face-to-face homogeneity of the above-mentioned resistivity also replaces the above-mentioned diboron hexahydride with boron trichloride (BCl₃), it has become clear that it is improved substantially. For example, in the boron dope polish recon film produced using a mono silane (SiH₄) and boron trichloride, resistivity face-to-face homogeneity is about 10% in the state of temperature the flat of 400-420 degrees C in the mono-silane partial pressure of 63.4Pa, and the boron trichloride partial pressure of 3.2Pa.

[0007]

[Problem(s) to be Solved by the Invention] However, when boron trichloride is used as gas for a boron dope, the homogeneity within a thickness side in a bottom product field (slot location No 11-36) is 5 - 6%, and it has been an important practical technical problem to improve further not a value with this value low enough as an object for manufacture of a semiconductor device but the homogeneity within this thickness side.

[0008] Moreover, although it is a good value as compared with the result in diboron hexahydride gas when boron trichloride is used also about the face-to-face homogeneity of resistivity, when it thinks on production level, it is inadequate, and it is required that this resistivity face-to-face homogeneity should be 3% or less.

[0009] Change by the location in a reactor of a boron trichloride partial pressure is mentioned to one of the reasons nil why resistivity face-to-face homogeneity is bad. Although the inside of a reactor is gone up and exhausted, since specific consumption with a mono silane is different, being consumed by membrane formation, the boron trichloride gas introduced in the reactor can consider that the partial pressure of boron trichloride gas is changing with the locations in a furnace. Then, it is desirable to make resistivity into homogeneity with face-to-face, without being influenced by change of a boron-trichloride-gas partial pressure, and it is important practically to search for the conditions for realizing it.

[0010] The object of this invention is the manufacture approach of the semiconductor device which solves the above-mentioned technical problem, uses a mono silane and boron trichloride, and forms a boron dope silicone film on a substrate with a CVD method, and is offering the manufacture approach of a semiconductor device the homogeneity within a thickness side enabling production of a good boron dope silicone film.

[0011] Moreover, other objects of this invention are the manufacture approaches of the semiconductor device which solves the above-mentioned technical problem, uses a mono silane and boron trichloride, and forms a boron dope silicone film on a substrate with a CVD method, and are offering the manufacture approach of a semiconductor device resistivity face-to-face homogeneity's enabling production of a good boron dope silicone film.

[0012]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, as the 1st means, a mono silane and boron trichloride are used for this invention as reactant gas, and it sets them in a reactor. In the manufacture approach of the semiconductor device which forms a boron dope silicone film on a substrate with a CVD method constitute the manufacture approach of the semiconductor device characterized by making whenever [said reactor internal temperature / at the time of said boron dope silicone film membrane formation] into 460 degrees C or more less than 600 degrees C, and it sets for said 1st means as the 2nd means. Where laminating support of two or more substrates is perpendicularly carried out in said reactor at a boat introduce gas, make it go up perpendicularly, constitute the manufacture approach of the semiconductor device characterized by forming a boron dope silicone film on each aforementioned substrate with a heat CVD method from the furnace body lower part, and it sets for said 1st means as the 3rd means. constitute the manufacture approach of the semiconductor device characterized by making whenever [said reactor internal temperature / at the time of said boron dope silicone film membrane formation] into 480 degrees C or more less than 600 degrees C, and it sets for said 1st means as the 4th means. constitute the manufacture approach of the semiconductor device characterized by making whenever [said reactor internal temperature / at the time of said boron dope silicone film membrane formation] into 520 degrees C or more less than 600 degrees C, and it sets for said 1st means as the 5th means. constitute the manufacture approach of the semiconductor device characterized by making sum total mean velocity of the gas in said reactor at the time of said boron dope silicone film membrane formation into the following by 3890cm/, and it sets for said 3rd means as the 6th means. constitute the manufacture approach of the semiconductor device characterized by making sum total mean velocity of the gas in said reactor at the time of said boron dope silicone film membrane formation into the following by 3990cm/, and it sets for said 4th means as the 7th means. The manufacture approach of the semiconductor device characterized by making sum total mean velocity of the gas in said reactor at the time of said boron dope silicone film membrane formation into the following by

4200cm/s is constituted. As the 8th means Use a mono silane and boron trichloride as reactant gas, and it sets in a reactor. In the manufacture approach of the semiconductor device which forms a boron dope silicon film on a substrate with a CVD method Constitute the manufacture approach of the semiconductor device characterized by making sum total mean velocity of the gas in said reactor at the time of said boron dope silicon film membrane formation into the following by 2200cm/s, and it sets for said 8th means as the 9th means. Where laminating support of two or more substrates is perpendicularly carried out in said reactor at a boat Introduce gas, make it go up perpendicularly, constitute the manufacture approach of the semiconductor device characterized by forming a boron dope silicon film on each aforementioned substrate with a heat CVD method from the furnace body lower part, and it sets for said 8th means as the 10th means. Constitute the manufacture approach of the semiconductor device characterized by making sum total mean velocity of the gas in said reactor at the time of said boron dope silicon film membrane formation into the following by 1470cm/s, and it sets for said 8th means as the 11th means. Constitute the manufacture approach of the semiconductor device characterized by making sum total mean velocity of the gas in said reactor at the time of said boron dope silicon film membrane formation into the following by 730cm/s, and it sets for said 8th means as the 12th means. Constitute the manufacture approach of the semiconductor device characterized by making whenever [said reactor internal temperature / at the time of said boron dope silicon film membrane formation] into 400 degrees C or more less than 600 degrees C, and it sets for said 8th means as the 13th means. The manufacture approach of the semiconductor device characterized by making whenever [said reactor internal temperature / at the time of said boron dope silicon film membrane formation] into 400 degrees C or more 440 degrees C or less is constituted. As the 14th means Where laminating support of two or more substrates is perpendicularly carried out in a reactor at a boat In the manufacture approach of the semiconductor device which introduce a mono silane and boron trichloride as reactant gas, and it is made to go up perpendicularly, and forms a boron dope silicon film on each aforementioned substrate with a heat CVD method from the furnace body lower part The sum total mean velocity of the gas in said reactor at the time of said boron dope silicon film membrane formation The manufacture approach of the semiconductor device characterized by considering as the rate of flow from which the homogeneity within a thickness side of said boron dope silicon film formed on each aforementioned substrate becomes 3% or less is constituted. As the 15th means Use a mono silane and boron trichloride as reactant gas, and it sets in a reactor. In the manufacture approach of the semiconductor device which forms a boron dope silicon film on a substrate with a CVD method The manufacture approach of the semiconductor device characterized by setting the partial pressure of the boron trichloride in said reactor at the time of said boron dope silicon film membrane formation to 0.7Pa or less is constituted. As the 16th means A mono silane and boron trichloride are used in the reactor heated at the heater. With a CVD method In the manufacture approach of the semiconductor device which forms a boron dope silicon film on a substrate It is installed in said reactor and the manufacture approach of the semiconductor device characterized by supplying said boron trichloride in said reactor through nozzle tubing which has the part which counters said heater, and the exhaust nozzle which emits gas to the upstream of the gas passageway in said reactor is constituted. The coil which processes a substrate inside as the 17th means, and the heater which is formed in the exterior of said coil and heats said substrate, In the substrate processor which has the nozzle which supplies a mono silane within [said] a reaction, and nozzle tubing which supplies boron trichloride within [said] a reaction, nozzle tubing which supplies said boron trichloride The substrate processor characterized by having the part which counters said heater in said reaction within the pipe one, and the exhaust nozzle which emits said boron trichloride to the upstream of the gas passageway in a reactor is constituted.

[0013]

[Embodiment of the Invention] In the preliminary consideration before [operation gestalt of ** 1st] this invention is made, the inclination which becomes so thin [the boron dope polish recon film whose homogeneity within a thickness side formed in the above-mentioned bottom product field is 5 - 6% is thick in a wafer core, and] that it goes outside was seen. If this takes into consideration the catalyst effectiveness of making the membrane formation rate which boron has increasing, it is possible that it did not fully decompose, but it is disassembled into **** in case boron trichloride gas

is diffused in the direction of the wafer inside with a bottom product field wafer lateral part. Although the effect by distribution is also cited as a cause whenever [wafer side internal temperature], since there is neither the temperature stabilization time amount before membrane formation nor the dependency of the homogeneity within the thickness side to the existence of a bottom product field lower part dummy wafer, it is hard to consider it. Making boron trichloride decompose enough from these results, by the time it arrives at a bottom product field can say that it is important when improving the homogeneity within a thickness side of a bottom product field. This invention is made based on such consideration.

[0014] Where it used a mono silane (SiH_4) and boron trichloride (BCl_3) as reactant gas and laminating support of two or more wafers is perpendicularly carried out in a reactor at a boat. Introduce gas from the furnace body lower part, it is made to go up perpendicularly, and the gas is used. With a heat CVD method The structure schematic diagram of the hot wall-type batch type vertical mold low pressure CVD system which forms a boron dope silicon thin film, i.e., a boron dope amorphous silicon thin film, or a boron dope polish recon thin film on said wafer is shown in drawing 1.

[0015] A hot wall furnace is constituted, the coil 1 made from a quartz, i.e., an outer tube, which is the outer case of a reactor 10, and the inner tube 2 of the outer-tube 1 interior make a shaft vertical, and are installed in the heaters [which were divided into four zones / 6a-6d] inside which heats the wafer 4 as a substrate, and vacuum suction of between two sorts of these tubes is carried out using the mechanical booster pump 7 and the dry pump 8. Therefore, the reactant gas introduced into the inner tube 2 inside goes up the inside of an inner tube 2 vertically, it descends and between two sorts of tubes is exhausted. The overall length of an inner tube 2 is about 1250-1260mm, a bore is about 250-270mm, the overall length of an outer tube 1 is about 1270-1280mm, a bore is about 290-310mm, and the volume of a reaction is 3 about 66600cm³-66700cm³.

[0016] When a core is arranged, the boat 3 made from a quartz with which it was perpendicularly loaded by carrying out a laminating is installed in an inner tube 2 and two or more wafers 4 are exposed to reactant gas, a thin film is formed on a wafer 4 of the reaction in the inside of a gaseous phase, and wafer 4 front face. A heat insulation plate 5 is for equalizing the temperature of location within the limits where a wafer 4 exists. Moreover, nine are a boat revolving shaft among drawing 1.

[0017] In addition, a total of 172 slots which support a wafer 4 is prepared in the boat 3, it counts from the bottom slot, and to 10 slot eye, the wafer 4 of a product is supported to a 11 to 167 slot eye, and the dummy wafer 4 is supported [eye / 168 to 172 slot] for the dummy wafer 4. Moreover, the top field in drawing 1, the center field, and the bottom product field show the thing of the field where the wafer 4 of the product to a 129 to 167 slot eye exists, the field where the wafer 4 of the product to a 37 to 128 slot eye exists, and the field where the wafer 4 of the product to 11 to 36 slot eye exists, respectively. Bottom L (Lower) zone (it corresponds to heater 6d) among the heater zones divided into four. Moreover, under surface than 1 slot eye, The wafer supports the field which hardly exists and second CL (Center Lower) zone (it corresponds to heater 6c) is equivalent to the field to which the wafer 4 of the dummy to 2 to 56 slot eye and the wafer 4 of a product are intermingled from the bottom. Second CU (Center Upper) zone (it corresponds to heater 6b) is equivalent to the field to which the wafer 4 of the product to a 57 to 172 slot eye and the dummy wafer 4 are intermingled from on [from the bottom] the third. Fourth top U (Upper) zone (it corresponds to heater 6a) is equivalent to the field to which the wafer above it does not exist from the bottom. Moreover, with the nozzle which supplies a mono silane (SiH_4), from the heater and the field which counters, the quartz nozzle which supplies boron trichloride gas (BCl_3) is a lower part, and is prepared in the throat section (inside of drawing, lower left) of the method of reaction jurisdiction, respectively. Moreover, a heat insulation plate 5 is installed below heater 6d corresponding to L zone.

[0018] A membrane formation procedure is shown in drawing 3. After making membrane formation temperature stabilize the inside of a reactor 10 first, the boat 3 loaded with a wafer 4 is loaded in a reactor 10 (insertion). The inside of a reactor (reactor 10) is exhausted, and N₂ purge is performed in order to desorb the moisture which stuck to a boat 3 or tubes 1 and 2. After performing a reactor (reactor 10) inner leak check, the flow rate of a mono silane and boron trichloride is set up, in a

reactor 10, gas is passed, a pressure is stabilized and membrane formation of a boron dope silicon film, i.e., the boron dope amorphous silicon film, or the boron dope polish recon film is performed. If membrane formation is completed, the cycle purge of the inside of piping will be carried out by N₂, and the inside of a reactor is returned to atmospheric pressure by N₂. If it returns to an atmospheric pressure, the unload of the boat 3 will be carried out, and a wafer 4 is cooled naturally. Finally a wafer 4 is picked out from a boat 3.

[0019] [Example 1]

(Elevated-temperature-izing of membrane formation temperature) A dependency is shown in drawing 4 whenever [furnace temperature / of the homogeneity within a bottom product field thickness side]. The homogeneity within a thickness side (however, since it expresses with the percentage of the amount of ununiformities within a thickness side, homogeneity is so good that the numeric value of an axis of ordinate is small), and the axis of abscissa of an axis of ordinate are whenever [furnace temperature] among drawing. In this case, the partial pressures of a mono silane and boron trichloride are 69.3Pa and 0.7Pa, respectively, and flow rates are 500sccm and 5sccm(s), respectively.

[0020] As drawing 4 shows, by raising whenever [furnace temperature], decomposition of boron trichloride is promoted and the good homogeneity within a thickness side is especially acquired above 480 degrees C whenever [furnace temperature]. What is necessary is just to make whenever [membrane formation temperature, i.e., furnace temperature,] into 460 degrees C or more, for example, 480 degrees C, in such a case, since the film may be able to be used, if the homogeneity within a thickness side becomes 3% or less depending on the class of semiconductor device. As drawing 4 shows, homogeneity within a thickness side in a bottom product field can be made into 2% or less by being able to make homogeneity within a thickness side in a bottom product field into 3% or less, and making membrane formation temperature into 480 degrees C or more by making membrane formation temperature into 460 degrees C or more. Moreover, homogeneity within a thickness side in a bottom product field can be made into 1% or less by making membrane formation temperature into 520 degrees C or more. However, if membrane formation temperature is made into 600 degrees C or more, since the problem of buildup of the resistivity by the lack of boron trichloride and aggravation of the homogeneity within the thickness side of the top and a center field will arise, as for membrane formation temperature, it is desirable that it is less than 600 degrees C.

[0021] In order to make homogeneity within a thickness side good from the above thing, without increasing resistivity, it is desirable to make membrane formation temperature into 460 degrees C or more less than 600 degrees C. Moreover, if membrane formation temperature is made into 480 degrees C or more less than 600 degrees C, since homogeneity within a thickness side can be made still better, without increasing resistivity, it is more desirable.

[0022] In the above-mentioned patent reference 1, using silicon material, such as a silane (SiH₃), and dope gas, such as PH₃ and BCl₃, it is sheet mode of processing and the approach of forming the polish recon layer doped on the wafer at the wafer temperature of about 600 to about 700 degrees C is indicated. However, the above-mentioned wafer temperature requirement given in the patent reference 1 is a thing at the time of using PH₃ as dope gas, and is not a thing at the time of using BCl₃. From the case where PH₃ is used, since the methods of a reaction completely differ, naturally the case where BCl₃ is used differs also in wafer temperature. As shown in this example and the below-mentioned example, when forming the silicon film which had boron doped in this invention using a mono silane and boron trichloride, temperature of less than 600 degrees C is made into desirable membrane formation temperature.

[0023] As explained above, by elevated-temperature-ization of membrane formation temperature, the homogeneity within a thickness side in a bottom product field can be reduced to about 1%, the homogeneity within a thickness side can be improved, and since the homogeneity within a thickness side can put now 5 - 6%, and the wafer of the bottom product field (slot locations 11-No 36) which it is bad and has been discarded on a production line until now, productivity can be raised substantially.

[0024] [Example 2]

(Low-speed-izing of a gas flow rate) It is as the example 1 having described that the method of improving the homogeneity within a thickness side by elevated-temperature-ization whenever

[furnace temperature] is effective since decomposition of boron trichloride is promoted by raising whenever [furnace temperature]. However, it is necessary to promote decomposition of boron trichloride, without having to form membranes, for example at the temperature of 440 degrees C or less depending on the class of semiconductor device, and raising temperature in such a case. Then, this invention persons found out the approach of promoting decomposition of boron trichloride (it low-speed-izing) by controlling a gas flow rate.

[0025] The sum total flow rate dependency of the mono silane of the homogeneity within a thickness side and boron trichloride is shown in drawing 5. The homogeneity within a thickness side (however, since it expresses with the percentage of the amount of ununiformities within a thickness side, homogeneity is so good that the numeric value of an axis of ordinate is small), and the axis of abscissa of an axis of ordinate are the sum total flow rates of a mono silane and boron trichloride among drawing. In this case, the flow rate of boron trichloride is set constant 5 sccms, the flow rate of a mono silane is decreased from 500sccm(s) to 100sccm(s), and whenever [furnace temperature] is forming membranes at 400-420 degrees C. The partial pressures of a mono silane and boron trichloride are 60.0-69.3Pa, 0.7-10Pa, and 70Pa in total, respectively.

[0026] By making a gas flow rate into abbreviation 1/5 from drawing 5 to conditions (C) A duration after gas is introduced in a reactor 10 until it arrives at a bottom product field can be enlarged, the time amount by which boron trichloride is heated can be extended, decomposition of boron trichloride can be promoted, and about 1% of homogeneity within a thickness side can be realized in all fields ((A) shows among drawing). For a bottom product field, No11 (from the bottom to the 11th sheet) and a center field are [No89 (from the bottom to the 89th sheet) and the top field of the slot location of the thickness monitor used at this time] No167 (from the bottom to the 167th sheet). What is necessary is just to form membranes all over drawing and under the conditions shown by (B) in such a case, since the film may be able to be used if the homogeneity within a thickness side becomes 3% or less depending on the class of semiconductor device as already stated. Namely, what is necessary is just to set the sum total flow rate of a mono silane and boron trichloride to 255sccm (s), when about 3% of homogeneity within a thickness side is allowed in all fields.

[0027] Furthermore, drawing 5 shows that the homogeneity within a thickness side becomes 3% or less in 300 or less sccms, then all fields about a sum total flow rate. Since the cross section of a gas passageway is 2 531cm, flow rate 300sccm in the pressure of 70Pa and the temperature of 400-420 degrees C becomes a part for 2200cm/of mean velocity. That is, boron dope polish recon film [as / whose homogeneity within a thickness side will be 3% or less in all fields if membranes are formed below by 2200cm/of mean velocity] will be obtained.

[0028] Moreover, drawing 5 shows that the homogeneity within a thickness side becomes 2% or less and 1% or less about a sum total flow rate, respectively in 200 or less sccms, 100 sccms or less, then all fields. Here, each mean velocity in case sum total flow rates are 200sccm(s) and 100sccm becomes a part for part 730cm/for 1470cm/. That is, boron dope polish recon film [as / whose homogeneity within a thickness side will be 2% or less in all fields if membranes are formed below by 1470cm/of mean velocity] will be obtained, and boron dope polish recon film [as / whose homogeneity within a thickness side will be 1% or less in all fields if membranes are formed below by 730cm/of mean velocity] will be obtained.

[0029] Moreover, drawing 5 shows that a boron dope silicone film [as / whose thickness homogeneity is 1 - 3% or less] is obtained in all fields, if membranes are formed considering sum total mean velocity as a part for part [for 730cm/-], and 2200cm/.

[0030] As explained above, low-speed-ization of a gas flow rate enables it to make homogeneity within a thickness side in a bottom product field into about 1%. The homogeneity within a thickness side is improvable, and since the homogeneity within a thickness side can put now 5 - 6%, and the wafer of the bottom product field (slot locations 11-No 36) which it is bad and has been discarded on a production line until now, productivity can be raised substantially. Moreover, in low-speed-ization of this approach, i.e., a gas flow rate, it can respond also to a low-temperature process.

[0031] In addition, whenever [furnace temperature], as 380-400 degrees C, when BCl₃ partial pressure, total pressure, and heat insulation plate number of sheets were changed and change of the homogeneity within a bottom product field thickness side was investigated, it was checked by experiment that BCl₃ partial pressure, total pressure, and heat insulation plate number of sheets are

all undependable to the homogeneity within a bottom product field thickness side. From these experiments, it became clear that whenever [sum total mean velocity / of reactant gas / and furnace temperature] affected most the homogeneity within a bottom product field thickness side.

[0032] In the experiment at the time of obtaining the result shown in drawing 4 of an example 1, the sum total mean velocity of the reactant gas kicked at each point of measurement is a part for 4200cm/, when [3990cm] whenever [furnace temperature] is 390 degrees C, it is part 410 degrees C for 3510cm/, it is part 450 degrees C for 3620cm/, and it is part 480 degrees C for 3830cm/and it is part 520 degrees C for /. Moreover, the sum total mean velocity when making whenever [furnace temperature] into 460 degrees C on the same conditions is a part for 3890cm/, and when it considers as 600 degrees C, it becomes a part for 4630cm/. As mentioned above, whenever [sum total mean velocity / of reactant gas / and furnace temperature] affects most the homogeneity within a bottom product field thickness side, and the direction [sum total mean velocity is a low speed] becomes good [the one where whenever / furnace temperature / is higher / the homogeneity within a bottom product field thickness side]. Therefore, if sum total mean velocity is made into the following by 3890cm/when whenever [furnace temperature] is made into 460 degrees C at least If sum total mean velocity is made into the following by 3990cm/when homogeneity within a thickness side in a bottom product field can be certainly made into 3% or less and whenever [furnace temperature] is made into 480 degrees C at least When homogeneity within a thickness side in a bottom product field can be certainly made into 2% or less and whenever [furnace temperature] is made into 520 degrees C at least, homogeneity within a thickness side in the following, then a bottom product field can be certainly made into 1% or less for sum total mean velocity by 4200cm/.

[0033] Moreover, in the experiment at the time of obtaining the result shown in drawing 5 of an example 2, whenever [furnace temperature] is performed as 400-420 degrees C. As mentioned above, whenever [sum total mean velocity / of reactant gas / and furnace temperature] affects most the homogeneity within a bottom product field thickness side, and the direction [sum total mean velocity is a low speed] becomes good [the one where whenever / furnace temperature / is higher / the homogeneity within a bottom product field thickness side]. Therefore, if sum total mean velocity is made into the following by 2200cm/when whenever [furnace temperature] is made into 400 degrees C at least [when homogeneity within a thickness side can be certainly made into 3% or less in all fields and whenever / furnace temperature / is made into 400 degrees C at least] [when homogeneity within a thickness side can be certainly made into 2% or less for sum total mean velocity in the following, then all fields by 1470cm/and whenever / furnace temperature / is made into 400 degrees C at least] Homogeneity within a thickness side can be certainly made into 1% or less for sum total mean velocity in the following, then all fields by 730cm/. In addition, also in this example, although it is desirable to consider as less than 600 degrees C like an example 1 as for membrane formation temperature, this example has the advantage that it can apply also when membranes must be formed less than as low temperature, for example, 440 degrees C, rather than an example 1.

[0034] [Example 3]

(Preheating of boron trichloride) The structure schematic diagram of the hot wall-type batch type vertical mold low pressure CVD system as a substrate processor in this example is shown in drawing 6.

[0035] Since it is above-mentioned examples 1 and 2 and an above-mentioned EQC except the point using a return nozzle as a nozzle which supplies boron trichloride about the configuration of a substrate processor, and the approach of forming membranes on a substrate as one process of semiconductor device manufacture using this substrate processor, the return nozzle which is the characteristic part of this example here is mainly explained. In addition, a same sign is given to a thing equivalent to what was shown by drawing 1 among drawing 6, and the explanation is omitted.

[0036] As illustrated to drawing 6, like the conventional technique, by the nozzle 13 which is a lower part and was prepared in the method of reaction jurisdiction, a mono silane is supplied in a reactor 10 and supplies boron trichloride in a reactor 10 through the return nozzle 12 from a heater and the field which counters. The return nozzle 12 corresponds to nozzle tubing in the 16th means of the above, and the 17th means, and is set in a reactor 10. Are going and coming back even to the height of the crowning (boat top-plate part) of the boat 3 in the field which is a lower part and

counters with a heater 6 from a heater 6 and the field which counters from the height of the pars basilaris ossis occipitalis of the boat 3 of the method of reaction jurisdiction so that it may be heated at a heater 6. It has the exhaust nozzle which emits boron trichloride to the upstream rather than the wafer 4 of the gas passageway in a reactor 10. That is, the return nozzle 12 is a heater 6 and the U character mold nozzle which goes via the field which counters. The boron trichloride supplied [be / it / under / return nozzle 12 / letting it pass] in a reactor 10 is supplied to the upstream of the above-mentioned passage in a reactor 10 in the condition of having been heated.

[0037] As a return nozzle 12 in drawing 6 , the overall length of a U character part (a part for the reciprocating part from reactor 10 pars basilaris ossis occipitalis to the height of a boat top-plate part) About 2.6m, Whenever [reactor 10 internal-temperature] using the quartz tube whose bore is about 4mm under the conditions of having 390 degrees C, the pressure of 70Pa, flow rate 500sccm of a mono silane, flow rate 5sccm of boron trichloride, and no dilution gas When the boron dope polish recon film was formed on the wafer 4, compared with the case where boron trichloride is supplied through a nozzle 13 and the same usual nozzle, the homogeneity within a thickness side is improvable about 10%.

[0038] It is using the return nozzle 12 which the above-mentioned result's is heated in a reactor 10, and moreover has long passage. By extending the time amount by which a duration after boron trichloride is introduced in a reactor 10 until it arrives at a bottom product field is enlarged, and boron trichloride is heated with the tubing wall of the return nozzle 12 After fully heating boron trichloride, it supplies in a reactor 10, and it is thought that it is because decomposition of the boron trichloride in a reactor 10 was promoted.

[0039] Moreover, decomposition of boron trichloride can be promoted by extending the time amount from which the rate of flow of the boron trichloride in a nozzle can be made late, and boron trichloride is heated by decreasing the boron trichloride flow rate in the return nozzle 12, and enlarging the tube inner diameter of the return nozzle 12, and making the cross section in tubing increase.

[0040] Moreover, as shown in drawing 7 , even if it uses W typeface ((a) in drawing), and nozzle tubing [being wavelike ((b) in drawing), or spiral ((c) in drawing)] besides return nozzle 12 of drawing 6 , it becomes improvable [the homogeneity within / the / as the above / same / a thickness side]. When it is used having replaced these nozzle tubing with the return nozzle 12, namely, these nozzle tubing Since it counters with a heater 6 in a reactor 10, and it has the part heated at a heater 6, and the exhaust nozzle which emits boron trichloride to the upstream rather than the wafer 4 of a gas passageway, therefore it has the overall length longer than the usual nozzle Since many parts of nozzle tubing are heated at a heater 6 and boron trichloride is moreover heated with the wall of such nozzle tubing by using such nozzle tubing After fully heating boron trichloride, the upstream of the gas stream in a reactor 10 can be supplied, and the homogeneity within a thickness side can be improved as the result. In addition, among drawing 7 , an arrow head shows the direction where gas flows, and the edge on the right-hand side of each nozzle tubing serves as an exhaust nozzle. Moreover, the number of the exhaust nozzles which emit boron trichloride may be one, and even if it is plurality, it is not cared about.

[0041] The structure schematic diagram of the hot wall-type batch type vertical mold low pressure CVD system as a substrate processor in a [operation gestalt of ** 2nd] book operation gestalt is shown in drawing 8 . About the configuration of a substrate processor, and the approach of forming membranes on a substrate as one process of semiconductor device manufacture using this substrate processor Except the point using two or more nozzles from which die length differs as a nozzle which supplies boron trichloride, and the point which controls the partial pressure of BCl₃ Since it is the 1st above-mentioned operation gestalt and above-mentioned EQC, how to control two or more nozzles which are the characteristic parts of this operation gestalt here and from which die length differs, and the partial pressure of BCl₃ is mainly explained. In addition, a same sign is given to a thing equivalent to what was shown by drawing 1 among drawing 8 , and the explanation is omitted.

[0042] That from which die length differs is installed in the two or more reactor 10, and the quartz nozzle for introducing boron trichloride into the inner tube 2 inside can supply boron trichloride the middle from two or more places, and can control the partial pressure of boron trichloride gas (BCl₃) in each [in a reactor 10] location. Moreover, the nozzle for introducing a mono silane is prepared in

the method of reaction jurisdiction.

[0043] A total of five quartz nozzles which supply boron trichloride gas (BCl_3) is prepared. With the nozzle which supplies a mono silane (SiH_4), from the heater and the field which counters, one is a lower part and it is prepared in the throat section (inside of drawing, lower left) of the method of reaction jurisdiction. Four of others It is prepared at equal intervals, respectively and boron trichloride consists of two or more [in a reactor 10] possible [supply] the middle so that it may pass along said throat section and each exhaust nozzle may correspond to the location of 30 slot eye, 70 slot eye, a 110 slot eye, and a 150 slot eye.

[0044] In the case of membrane formation, it can control by decreasing the flow rate of boron trichloride or diluting boron trichloride to make a boron trichloride partial pressure low, and the resistivity face-to-face (between wafers) homogeneity of the boron dope silicone film formed can be improved. Moreover, controlling the boron trichloride flow rate from the quartz nozzle installed two or more in the reactor 10 (a boron trichloride partial pressure being controlled) can also improve resistivity face-to-face homogeneity.

[0045] [Example 4]

(Optimization of a boron trichloride partial pressure) The boron trichloride partial pressure dependency of the resistivity at the time of using the above-mentioned equipment for drawing 9, and forming a boron dope silicone film in two or more wafers by the above-mentioned approach is shown. In this case, the partial pressure of a mono silane is 60.0-69.3Pa, that flow rate is 500sccm(s) and reaction temperature is 390 degrees C or 450 degrees C.

[0046] In drawing 9, it sets to all fields, i.e., the top, a center, and a bottom product field (No in a display and drawing shows the wafer loading slot location of a boat 3 to drawing 8). A boron trichloride partial pressure near 0.7Pa or in not more than it (for example, 0.06Pa of points in drawing 9, 0.2Pa) In the field in which a boron trichloride partial pressure exceeds 0.7Pa, the degree of change to the boron trichloride partial pressure of resistivity comparatively small (the inclination of the curve which connected each point among drawing being loose in comparison) The inclination for the degree of change to the boron trichloride partial pressure of resistivity to become large rapidly (for the inclination of the curve which connected each point among drawing to become sudden) is seen. That is, if membranes are formed by setting a boron trichloride partial pressure to about 0.7Pa or less, even if distribution will be possible for a boron trichloride partial pressure in the face-to-face (between wafers) direction (perpendicular direction) by consuming boron trichloride in a reactor 10, there is little change of resistivity and it can be said to be good [the face-to-face homogeneity of resistivity]. On the other hand, when membranes were formed in the range in which a boron trichloride partial pressure exceeds 0.7Pa and distribution is completed in a boron trichloride partial pressure in the face-to-face (between wafers) direction (perpendicular direction) by consuming boron trichloride in a reactor 10, it turns out that change of resistivity becomes large and the face-to-face homogeneity of resistivity worsens.

[0047] Therefore, as for the partial pressure of the boron trichloride in the reactor 10 at the time of membrane formation, it is desirable to be referred to as 0.7Pa or less.

[0048] From drawing 9, the partial pressure of the boron trichloride in the reactor 10 at the time of membrane formation is understood that it is desirable to be referred to as 0.06Pa - 0.7Pa.

[0049] The boron trichloride partial pressure dependency of resistivity face-to-face homogeneity is shown in drawing 10. However, resistivity face-to-face homogeneity is expressed with the percentage of the amount of resistivity face-to-face ununiformities among drawing (homogeneity is so good that the numeric value of an axis of ordinate is small). In this case, the partial pressure of a mono silane is 60.0-69.3Pa, that flow rate is 100 - 500sccm, and reaction temperature is 400-420 degrees C.

[0050] Drawing 10 shows that resistivity face-to-face homogeneity is improved with lowering of a boron trichloride partial pressure.

[0051] From the two above-mentioned results, in a steep field (field where a boron trichloride partial pressure exceeds 0.7Pa), resistivity face-to-face homogeneity has a bad change of resistivity to a boron trichloride partial pressure, and it becomes possible to make resistivity face-to-face homogeneity into 10 (150-sheet field) to 5% or less, and can improve 50% or more because change of resistivity reduces a boron trichloride partial pressure to a loose field (0.7Pa or less) to a boron

trichloride partial pressure. The amount of resistivity face-to-face ununiformities deducted the minimum value from the maximum in the resistivity average in the top, a center, and a bottom product field, and it computed it by having doubled the value broken by the twice of the resistivity average in all fields 100.

[0052] (Optimization of the boron trichloride partial pressure in each [in a reactor] location) From the quartz nozzle installed two or more in the reactor 10, by what (it is 0.7Pa at all) boron trichloride is made into a partial pressure, respectively, and is supplied for the middle by about 0.1Pa from two or more places, it becomes possible to make resistivity face-to-face homogeneity into 10 (150-sheet field) to 4% or less, and can improve 60% or more.

[0053] As explained above, when change of resistivity reduces a boron trichloride partial pressure to ** or a kana field (0.7Pa or less) to a boron trichloride partial pressure, it becomes possible to make resistivity face-to-face homogeneity into 10 (150-sheet field) to 5% or less, and can improve 50% or more. Moreover, resistivity face-to-face homogeneity can be further improved by controlling the boron trichloride flow rate from the quartz nozzle installed two or more in the reactor 10 (a boron trichloride partial pressure being controlled), and it can expect to raise productivity substantially.

[0054]

[Effect of the Invention] A mono silane and boron trichloride are used by operation of this invention, it is the manufacture approach of the semiconductor device which forms the boron dope polish recon film with a CVD method, and the manufacture approach of a semiconductor device that the homogeneity within a thickness side enables production of the good boron dope polish recon film can be offered.

[0055] Moreover, a mono silane and boron trichloride are used by operation of this invention, it is the manufacture approach of the semiconductor device which forms a boron dope silicone film with a CVD method, and the manufacture approach of a semiconductor device that resistivity face-to-face homogeneity enables production of a good boron dope silicone film can be offered.

[Translation done.]

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DESCRIPTION OF DRAWINGS**[Brief Description of the Drawings]**

[Drawing 1] It is the structure schematic diagram of the low pressure CVD system which forms a thin film as reactant gas using a mono silane (SiH_4) and boron trichloride (BCl_3).

[Drawing 2] It is drawing showing the wafer slot location dependency of the homogeneity within a thickness side.

[Drawing 3] It is drawing explaining the membrane formation procedure by the reduced pressure CVD method.

[Drawing 4] It is drawing showing a dependency whenever [furnace temperature / of the homogeneity within a bottom product field thickness side].

[Drawing 5] It is drawing showing the mono silane of the homogeneity within a thickness side, and a boron trichloride sum total flow rate dependency.

[Drawing 6] It is the structure schematic diagram of the low pressure CVD system which forms a thin film as reactant gas using a mono silane (SiH_4) and boron trichloride (BCl_3) which is the example of a gestalt of operation of the substrate processor concerning this invention.

[Drawing 7] It is drawing showing the example of a configuration of nozzle tubing concerning this invention.

[Drawing 8] It is the structure schematic diagram of the low pressure CVD system which forms a thin film as reactant gas using a mono silane (SiH_4) and boron trichloride (BCl_3).

[Drawing 9] It is drawing showing the boron trichloride partial pressure dependency of resistivity.

[Drawing 10] It is drawing showing the boron trichloride partial pressure dependency of resistivity face-to-face homogeneity.

[Description of Notations]

1 [-- A wafer, 5 / -- A heat insulation plate, 6 / -- A heater, 7 / -- A mechanical booster pump, 8 / -- A dry pump, 9 / -- A boat revolving shaft, 10 / -- A reactor, 11 / -- The lid made from stainless steel, 12 / -- A return nozzle, 13 / -- Nozzle.] -- An outer tube, 2 -- An inner tube, 3 -- A boat, 4

[Translation done.]

* NOTICES *

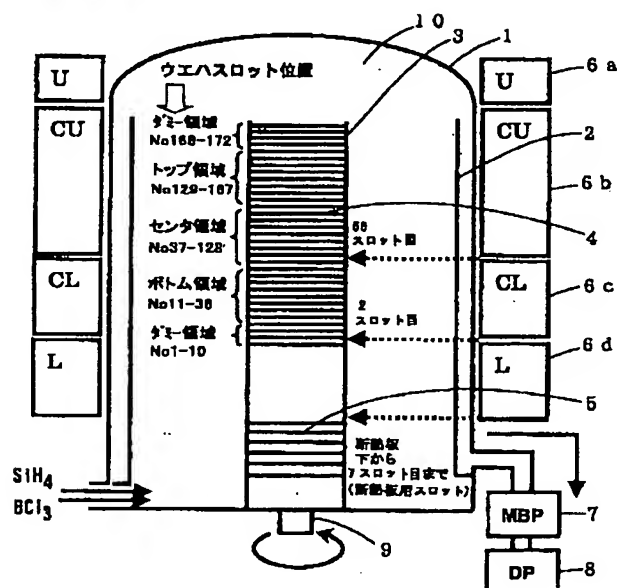
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DRAWINGS

[Drawing 1]

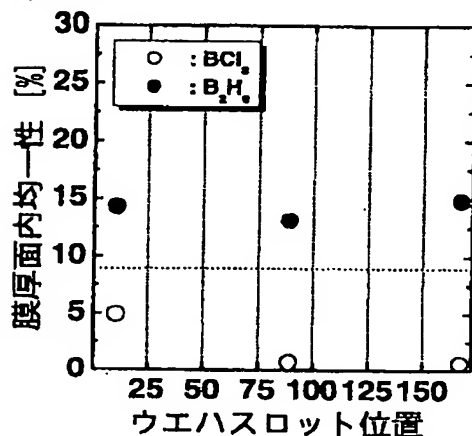
図 1



- 1...アウターチューブ、2...インナーチューブ、3...ポート、4...ウェハ、
5...断熱板、6...ヒータ、7...メカニカルブースタポンプ、
8...ドライポンプ、9...ポート回転軸、10...反応炉

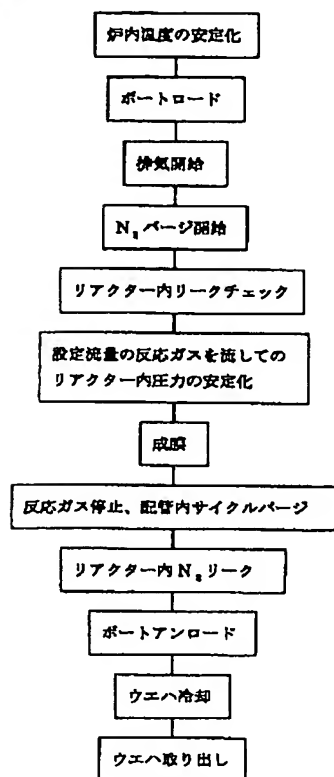
[Drawing 2]

図 2



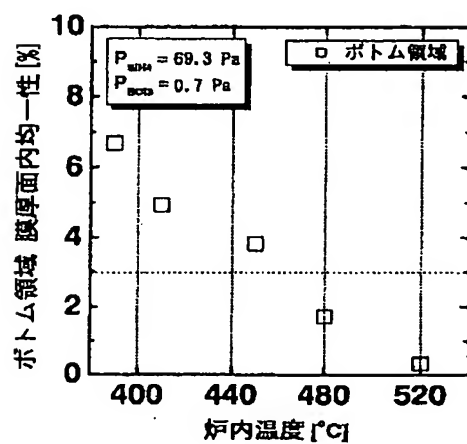
[Drawing 3]

図 3



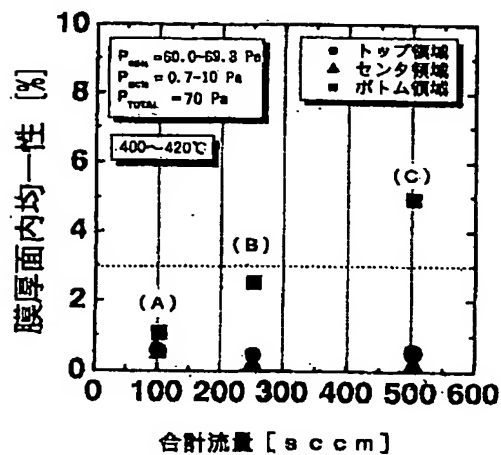
[Drawing 4]

図 4



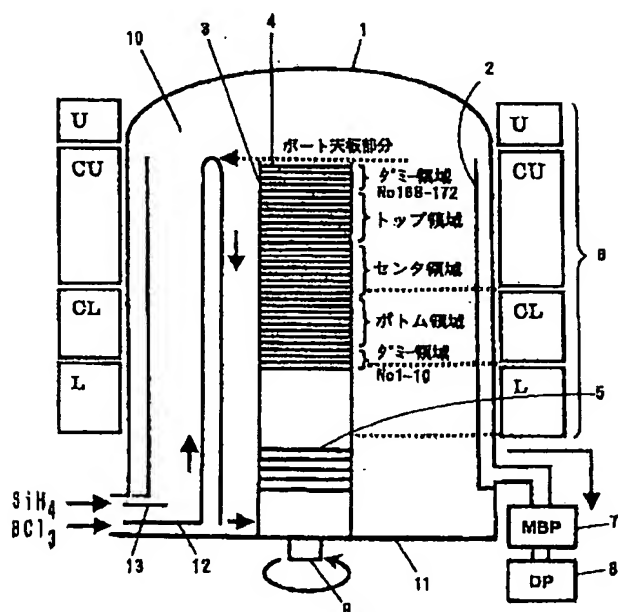
[Drawing 5]

図5



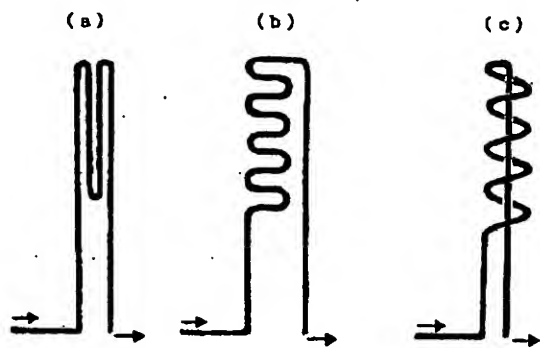
[Drawing 6]

図6



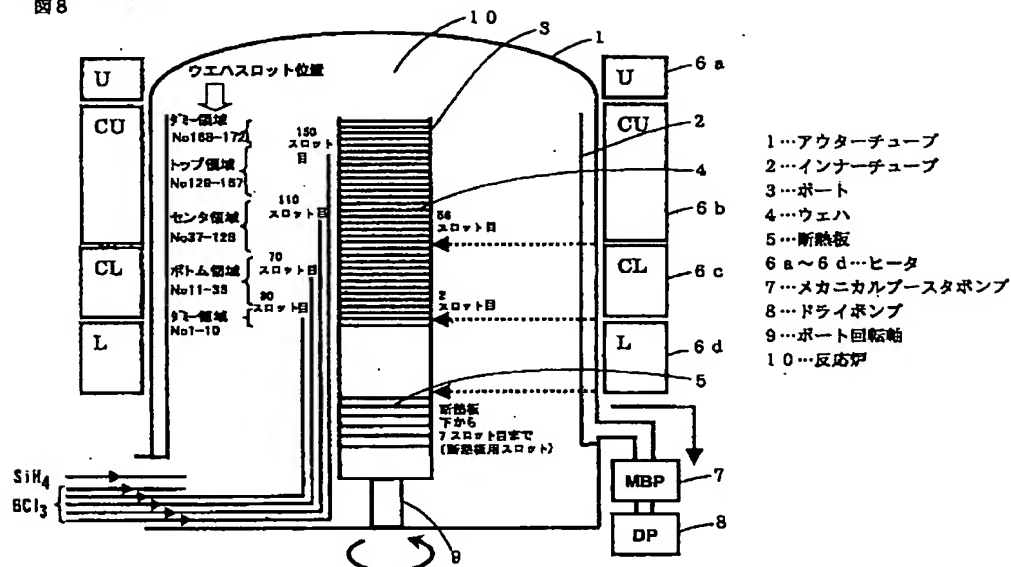
[Drawing 7]

図 7



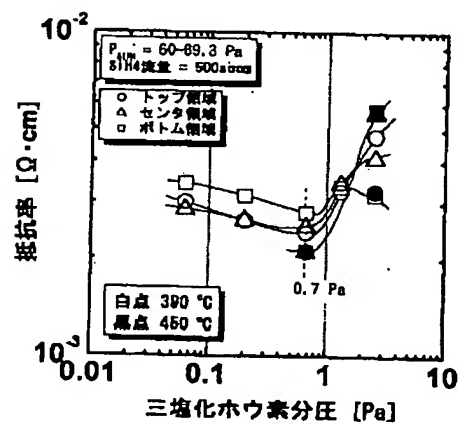
[Drawing 8]

図 8



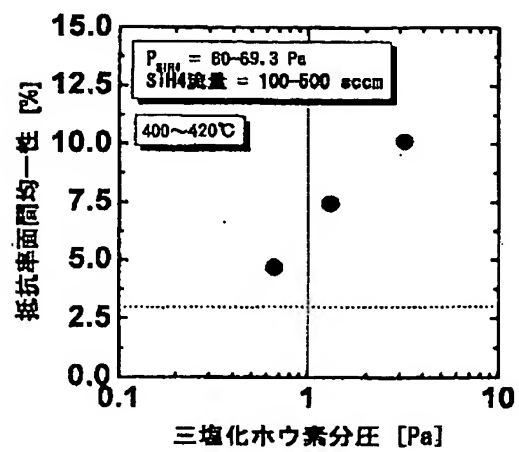
[Drawing 9]

図 9



[Drawing 10]

図10



[Translation done.]